# Understanding the Pathophysiology of Mitral Regurgitation: The First Step in Management

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*Mitral regurgitation is a frequent complication of coronary artery disease (CAD), and it also frequently co-exists with CAD. The surgical management of mitral regurgitation is dependent on its clinical presentation as well as the pathophysiology of regurgitation. A brief discussion of the pathophysiology of mitral regurgitation and a modified version of the Carpentier classification are presented.*

**Key words:** *mitral regurgitation, echocardiography, Carpentier classification.*

## Mitral Regurgitation

Mitral regurgitation (MR), also known as mitral insufficiency or mitral incompetence, is the reflux of blood from the left ventricle into the left atrium during cardiac systole.[1] The functional competence of the mitral valve relies on the coordinated interaction of the mitral annulus and leaflets, chordae tendineae, papillary muscles, left atrium and left ventricle (LV). Figure 1 illustrates the different components of the mitral apparatus. MR can result from failure of one or more of these components.

The clinical presentation of MR may vary from an asymptomatic patient with MR noticed on an echocardiogram done for post-myocardial infarction risk stratification, to a patient who presents in cardiogenic shock due to acute severe MR. On clinical examination a pan-systolic murmur is audible; the grade of the murmur does not correspond to severity. The symptoms and signs of heart failure may be associated with MR when it is hemodynamically significant. The time period over which MR develops dictates the degree to which the patient is able to compensate. Severe MR due to rupture of a papillary muscle trunk leads to acute circulatory collapse, whereas severe MR due to progressive degenerative disease that developed over several years in a patient with limited mobility may be asymptomatic.

A trans-thoracic echocardiogram is an excellent non-invasive screening test. A trans-esophageal echocardiogram is utilized to better describe the pathophysiologic defect.

## Etiology and Pathophysiology of Mitral Regurgitation

The most frequent causes of MR are degenerative (myxomatous) disease (20–40%), ischemic heart disease (15–35%), rheumatic disease (10–30%) and infectious endocarditis (5–15%).[1] Most textbooks define degenerative, ischemic and rheumatic MR as mitral regurgitation caused by the respective pathologic process. However, a practical definition that can be clinically applied to individual patients can be better specified by studying the pathophysiology of MR.

Carpentier, *et al.* introduced a pathophysiologic classification of MR.[2] The basis of this classification is mitral leaflet motion. MR with normal motion is type I, with increased motion is type II and with restricted motion is type III. A modified version is partially presented in Figure 2 and described in detail in the accompanying Table.

MR due to chordal elongation or rupture (types IIa and IIb) can be classified as degenerative MR. MR due to papillary muscle rupture, infarction, scarring or dysfunction (types IIc, IId and IV), or leaflet tethering by LV dysfunction (type IIIb) can be unequivocally classified as ischemic MR. Annular dilatation (type Ia) can be due to ischemic or degenerative (myxomatous) valve disease. In the presence of other features of degenerative valve disease and in the absence of significant ischemic disease, it is safe to classify type Ia MR as degenerative MR, and as ischemic MR otherwise.

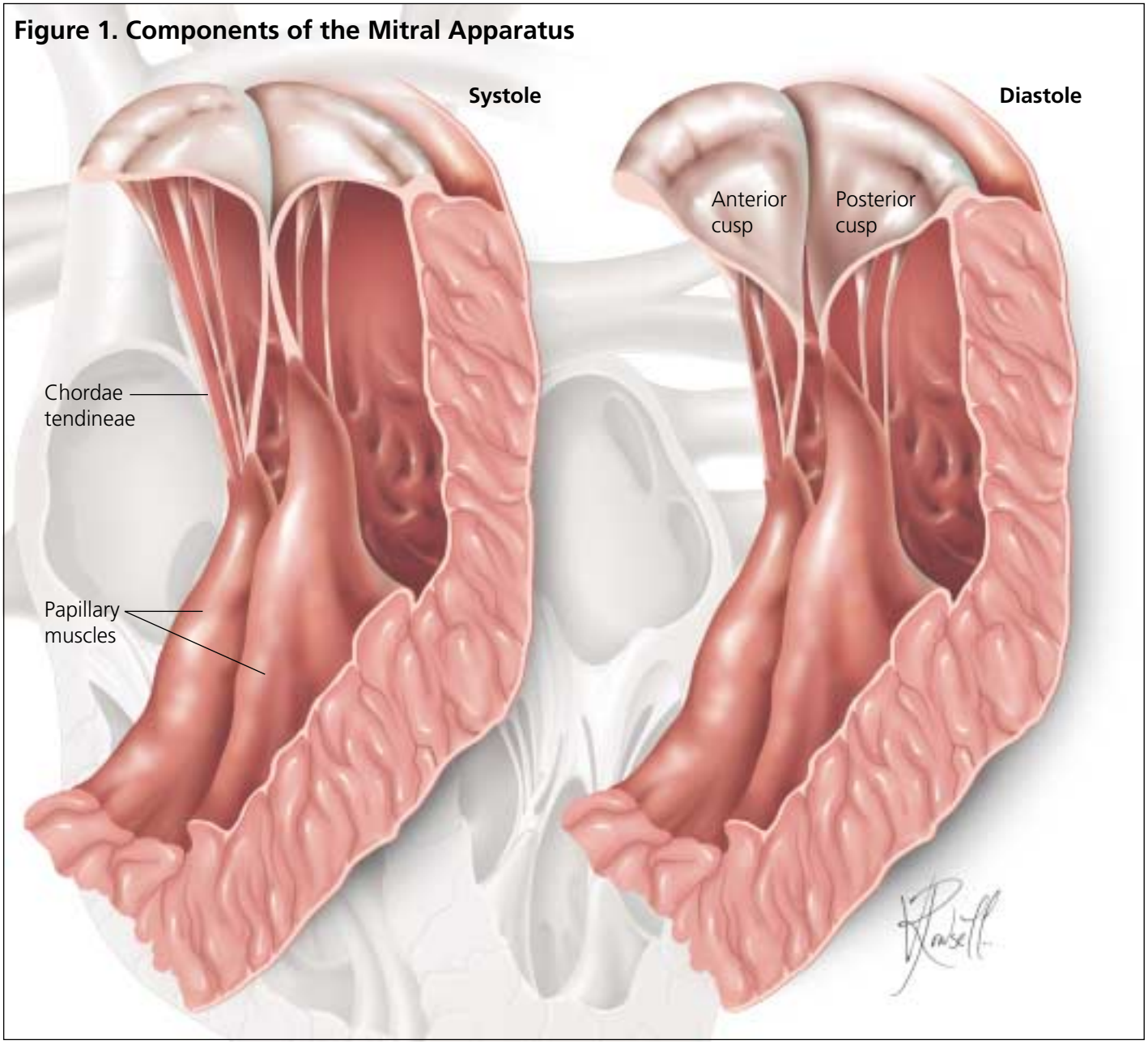
## Epidemiologic Interaction with Coronary Artery Disease

MR is a frequent complication of coronary artery disease (CAD). When MR is actively sought by echocardiography, it is detected in up to 35% of patients after a myocardial infarction.[3] Trans–esophageal echocardiography is superior to trans–thoracic echocardiography in describing the pathophysiology of MR. The prognostic importance of MR was shown in the Survival and Ventricular Enlargement study (SAVE).[4] The detection of mild or greater MR after a myocardial infarction was associated with an adjusted hazard ratio of cardiovascular mortality of 2.0 (95% CI: 1.28–3.04).

### Current Surgical Care

For patients with MR and CAD, the current standard of practice is to correct moderate or worse MR during coronary artery bypass grafting (CABG) by repairing or replacing the mitral valve.[5] Mitral valve replacement is a very common procedure performed by all cardiac surgeons since the early 1960s, and the prostheses used to replace the valve have evolved considerably over the years. The two

**Figure 1. Components of the Mitral Apparatus**



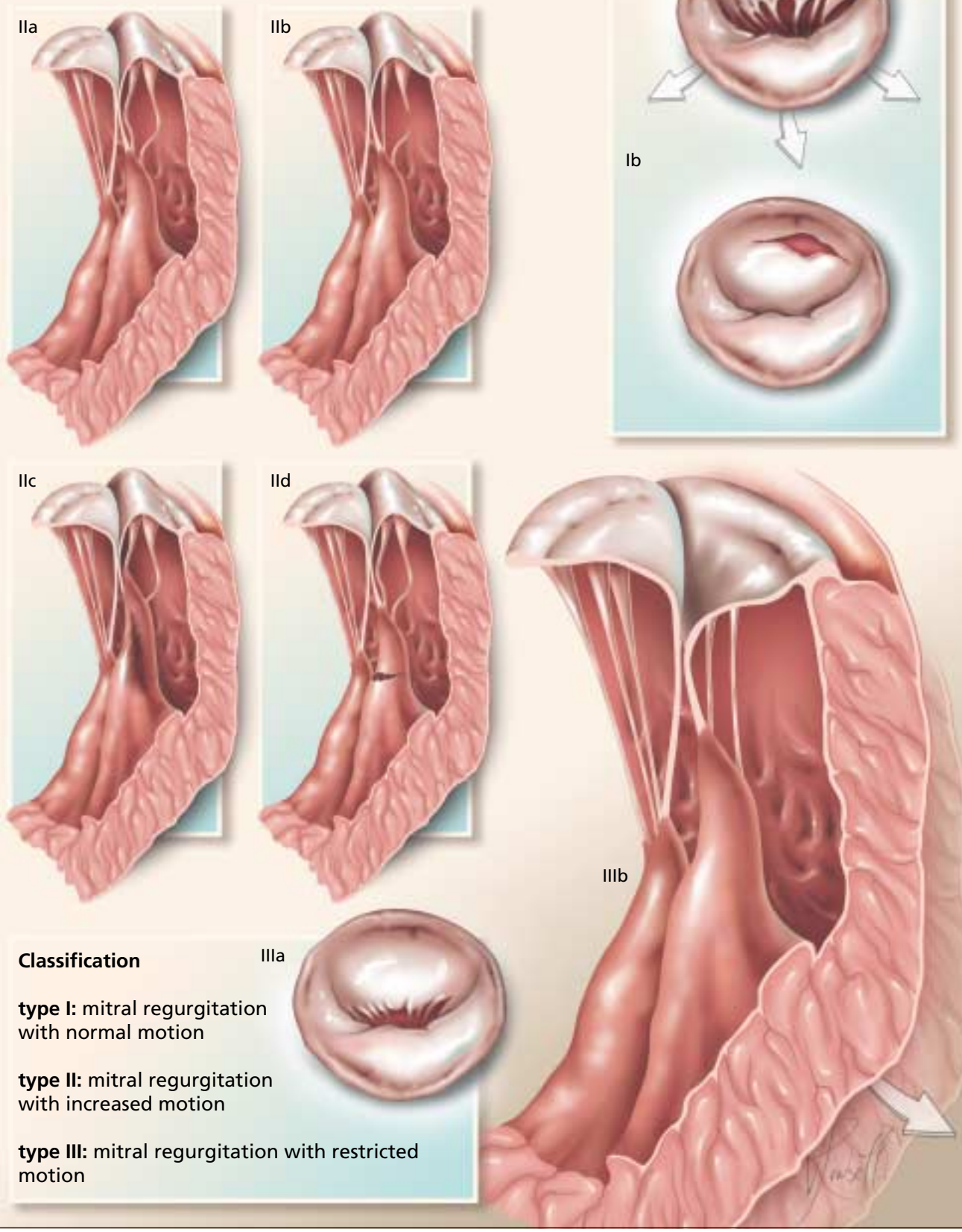

main types are mechanical and bioprosthetic valves. It is fair to say that at least since 1990, bileaflet mechanical valves (e.g., St. June Mechanical or Carbomedics) have largely replaced other types of mechanical prosthesis (e.g., ball and socket type valves). For bioprosthetic valves, the two main types are pericardial valves and porcine valves.

Mitral valve repair has been described as early as 1960; however, it has only become popular in the last 15 years after reports of superior results with repair compared to replacement in patients with degenerative mitral valve disease. Mitral valve repair is still performed preferentially in large centres. The techniques of repair are variable, and the specific one used depends on the pathophysiology of MR and the surgeon's skill and preference.

Advantages of mitral valve replacement include consistent results, technical ease and shorter cardiopulmonary bypass and operative times, which may be associated with fewer long-term complications of cardiopulmonary bypass. The disadvantages of replacement are the need for lifelong anticoagulation and detrimental effect on LV function due to distortion of LV dynamics. On the other hand, the advantages of mitral valve repair are preservation of the LV dynamics and function and the lack of need for long-term anticoagulation. The disadvantages of repair are inconsistent results, technical difficulty, need for re-operation for persistent or recurrent MR and potentially longer operative times if complex repairs or revisions are required.

In patients with MR and CAD, a distinction should be made between degenerative mitral regurgitation

**Figure 2.**
**Pathophysiologic Classification of Mitral Regurgitation**



**Modified Carpentier Classification of Mitral Regurgitation**

| | Leaflet Motion | Description |
|---|---|---|
| **Ia** | Normal | Annular dilatation |
| **Ib** | | Leaflet perforation |
| **IIa** | Increased | Chordal elongation |
| **IIb** | | Chordal rupture |
| **IIc** | | Papillary muscle infarction or scarring |
| **IId** | | Papillary muscle rupture |
| **IIIa** | Restricted | Commissural or chordal fusion and shortening |
| **IIIb** | | Leaflet tethering by dyskinetic or aneurysmal LV segments |
| **IV** | Variable | Dynamic papillary muscle dysfunction |

(DMR) coexistent with CAD and ischemic mitral regurgitation (IMR) caused by CAD. In the first instance, it is safe to say that most surgeons would elect to perform a CABG with mitral repair when the valve is repairable. However, in the case of IMR there is no consensus among surgeons.[5]

Age is not necessarily a limiting factor in terms of operability. Several reports in the literature describe the surgical results of older patients and octogenarians with outcomes comparable to younger patients when the expected survival of the population is taken into consideration. Even in the case of acute severe MR leading to cardiogenic shock, there are reports of successful operative interventions.[6] Therefore, the patient's general and specific comorbidity should shape the decision about operability, rather than age alone. ◆

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